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Motivational Change Realized by Cooperative Learning Applied In Thermodynamics

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Abstract
A teacher of a secondary school explained to two groups of 14 and 15-year-old students the thermodynamic correspondent to the curriculum of physics and chemistry. This is an obligatory subject for all the students. They followed two different methods: one group followed the traditional methodology and other one the strategy of the cooperative learning. The material was facilitated to him to give the classes. This experience lasted two months. We used two motivational tests: a pretest and a posttest, to see the effect of the methodologies in the students. The group that followed cooperative learning increased very much his interest for the physics, and the other group did not change, even decreased it.
Keywords: motivational, physics, interest, cooperative learning, traditional methodology.

Introduction

The students of the European Union (EU) "have a positive attitude towards the biology in 57% of the cases, 55% in case of the sciences of the land, 42% towards the chemistry and 38% towards the physics " (Eurydice, 2011: 22). In case of the thermodynamic, there are authors who affirm that "some students think that the thermodynamic is a difficult and horrible topic" (Handoyo, 2007). The 2009 PISA data referred to the learning of sciences demonstrate that many countries have a low scientific knowledge (PISA, 2009). As a consequence of it they are investing money in science education introducing new methodologies, for instance the learning based on problems and the cooperative learning (Eurydice, 2011).

These methods can be included in the general category of active learning methods. These sorts of methods include the learning based on projects and learning based on investigation, besides the mixings of these models (Malicky et al., 2006).

The learning based on problems focuses in opened problems that are chosen to take the students towards the expected learning. This method has used in diverse occasions in the physics education (Mettes et al., 1981; Hunter & Gonzalez, 2009; Tatar & Oktay, 2011). The learning based on projects is similar to the previous one; nevertheless a project substitutes a group of problems. Also there are several applications of this method in physics education (Blumenfeld et al., 1991; Cooper, 2004). The learning based on investigation consists of realizing some experiences, from which we have to answer to a series of questions and come to a few conclusions. There are some examples applied to the physics (Buch & Wolff, 2000; Tobin et al., 2011).

The cooperative learning has been defined as "small groups of persons who work together as a team to solve a problem, to realize a task or to come to a common goal" (Artz & Newman, 1990:448). The students must collaborate themselves to achieve these goals (Johnson & Johnson, 1999). Nevertheless, to get this positive interdependence is necessary a planned and well-considered process (Kagan & Kagan, 2009). This strategy can be realized by different ways giving satisfactory results of learning (Mendez, 2012). The characteristics of this strategy can be summarized in the following ones (Bará, Sunday & Valero, 2007):

1. Positive Interdependence: a student thinks that he is not going to have success if the remaining components of the group do not achieve it and vice versa.

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2. Positive Interaction: the students explain to themselves the way of solving problems or the nature of the concepts.
3. Personal Responsibility: the teacher should evaluate the results of every student.
4. Cooperative Skills for the effective functioning of the group: capacities like the leadership, the capture of decisions, ability to generate confidence …
5. Self-analysis of the group: discussion inside the group to know which goals has been achieved.

Also some experiences have been realized in physics, for example it has been done comparisons in the motivational field of a strategy of cooperative learning as the jigsaw and the model of direct instruction (Hänze & Berger, 2007), the effect of the collaboration between the students at the moment of solving problems of physics (Harskamp & Ding, 2006), the application of the cooperative learning with the help of the new technologies (Bell et al., 2010) and the study of the efficiency of the cooperative learning at the moment of solving some problems of electricity (Pathak et al., 2011). In addition, this strategy develops other important aspects as the solidarity, equality, respect, dialog and freedom (Gonzálvez et al., 2011).

Methodology

We measured the motivation and the learning of the 14 and 15-year-old students in physics and chemistry. The concepts were density, pressure, volume, temperature and heat. The students were distributed in two groups: one of 29 that followed the traditional methodology and other one of 28 that followed the cooperative learning. These students had had the previous year three months of physics in natural sciences and almost two months during this year in physics and chemistry.

The school made the groups two years ago; they wanted that the groups were as homogeneous as possible. The methodologies were applied of this form due to the fact that the classroom of the traditional group did not have audiovisual means and the classroom of another group yes, in addition this group was known by the teacher, this was interesting because, in order that the cooperative learning works, the teacher must know how to handle the dynamic of the groups and it is easier if the teacher knows the group (León del Barco, 2006).

The research was divided in several phases, the first phase was devoted to the preparation of the materials and to the design of the didactic unit, and we asked the teachers of the subject about the material. We elaborated a test of previous ideas and another final test of knowledge by the help of university professors, teachers of the school center and by help of the existing bibliography (Driver et al., 1989). We did a motivational pretest and posttest to measure the changes. The previous motivational test had six parts: Causal precedents of the motivation, degree of motivation in class and their performance, motivational power of the physics like subject, sources of motivation, dominant motives and motivational effects of the learning-teaching process.

Motivational tests

In the first part, the causal precedents of the motivation allow that the students should demonstrate his expectations and motivations before the year that begins. The test contains questions about the responsibility of the students, of the teacher and of the others in their success or failure.

The degree of motivation in class and the performance treats itself in the second part, it has as aim know the performance of the pupil in the past year, qualifying at the same time the interest, the attention, the effort for learning and the degree of dedication. Some questions of interest for which the response of the pupil is requested, say to the subject that they consider more interesting and that less interest wakes him up, the same with the attention, effort and degree of dedication. This second part of the test will repeat itself after the explanations of the experience. By this way the results can reveal if the methodologies have impact in the motivation and the performance.

In the third part, it is treated the motivational power of the subjects that they have to deal and of the Physics in the context of the remaining subjects: mathematics, language, English, social sciences, physics, chemistry, technology, physical education, biology and geology and plastic and visual education. Some aspects of the subject are specified requesting the students who demonstrate the reasons of the punctuation attributed to the Physics. This third part of the test is completed again after the process of withdrawal of information in the research.

The fourth part is focused towards the motivations on physics, offering to the student the opportunity to demonstrate his/her interests on the knowledge of the natural phenomena, of the devices of use in the daily life and social context, besides the characteristics of the Physics in comparison with other subjects, the materials of use of this subject, the book of text, the qualities of the teacher, etc.

The fifth part treats the dominant motives for the study of the Physics: the importance for the future work, the interest to know the scientific culture and the zeal for knowing the devices and scientific concepts overlapped in the mass media. This part will reveal if the interests of the student obey an intrinsic or extrinsic motivation.

The last part has as aim that the student shows the motivational effect that some attached situations have on him, which go from the congratulations of the teacher, the sanctions, the difficulty or facility of the tasks, the good results, the participation in the evaluation and in the curricular decisions, the individual work or in group, the competitions in class, the discovery of the phenomena and the use of audiovisual means.

The process

The students were divided in two groups, one followed the traditional methodology, it will be called “traditional group”, they used the textbook and the teacher explained the doubts, at the beginning of the class the teacher asked the contents of the previous day.

The other group followed cooperative learning and it will be called “cooperative group”, it was realized dividing the class in groups of three and of four students, in every group always there was one student of the top third and one of the low third. The teacher asked at the beginning of the class the contents seen the previous day, then he explained 10 minutes approximately, distributed the material and the students worked at groups, the teacher solved the doubts that were arising, in the last five minutes of class they gave the results of the different tasks and the teacher returned to solve some doubt if it was. The classes lasted one hour.

The teacher took note of the attitude of the students and of the daily work every day. He ordered assignments in order that they did them in house and asked 25% of the students daily.

On having concluded the period dedicated to the explanation, the final test of knowledge was completed and later the final motivation test, which consisted of two parts: the first one referred to the degree of motivation in class and his performance and the second

one to the motivational power of the physics. The second part was exactly like in the pretest because we were looking for if the results obtained on the motivations had changed and in what direction had produced the change, if it was.

Results

Motivational pretest.

Initially we express the results of the test before the explanation in which we have applied the different methodologies.

Causal precedents of the motivation

In this part the questions are about the confidence that they have in themselves and the need that they have of help to overcome successfully physics. Of the polled students, 45% trusts in their possibilities to overcome the study of physics and chemistry, affirms the need that they have of success in 60% and assume the responsibility of obtaining it in 82%. Approximately one fourth of the students say need of help but they do not transfer the responsibility to these persons who help them, only in case of the teacher 24% of the students affirm that their success or failure depends on them to a great extent.

Motivation in the class

The research identifies the degree of motivation in class and the performance in it. Around 66% of the students they affirm that they are very interested, attentive in class, make much effort and are constant to learn and to work. Only 15% recognizes their lack of perseverance in the work. As for the questions about the performance in subjects of previous years that have similarities with the physics and chemistry, 45% affirms to have succeeded in them, nevertheless, 13% recognizes the opposite in case of the mathematics and only 2% in case of natural sciences.

Concerning to the opinion of the students about the different subjects, which more preferences receive, 25-30%, are the two most important of the year: Spanish language and mathematics. As for the physics it is a practically indifferent subject but they consider it at the moment of referring to the effort and to the perseverance, approximately 5-10% of elections. Subjects with many choices are biology, geography and music. Other subjects also chosen are musical and arts.

Interest for every subject

The goal is to know the motivations of the students before the subjects that they deal. This investigation is carried out before beginning the experience. We have calculated the averages for being more illustrative than the singular information. The averages of interest are those that appear in the following graph:

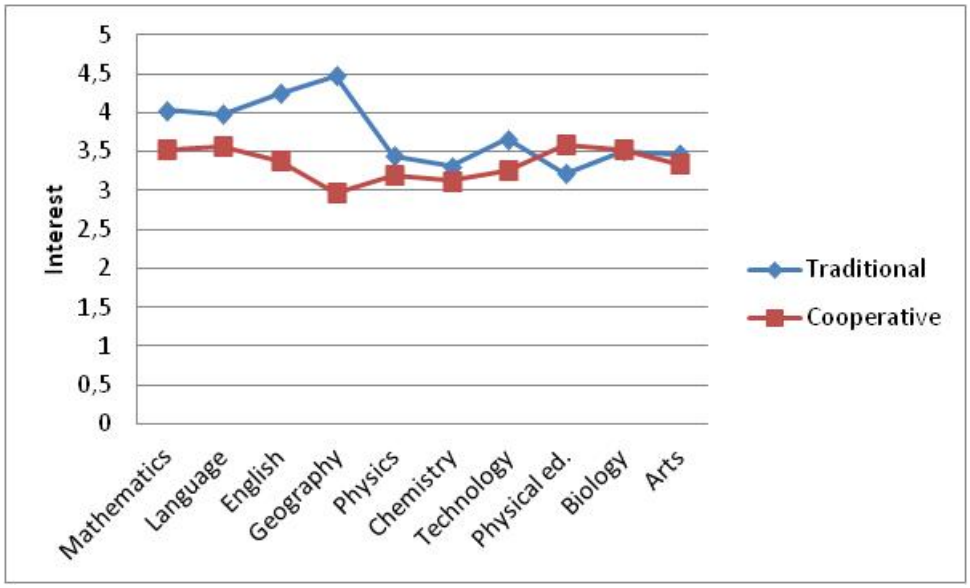

Figure 1. Motivational power of the subjects.

It is observed that traditional group likes geography, emphasizing also English, language and mathematics. The remaining subjects receive a similar punctuation. In the cooperative group, the students give similar punctuation to all the subjects. The favorite subjects are mathematical, language and physical education, nevertheless in the one that less they are interested it is geography. The geography teachers are different.
The motives that they express about the interest for the physics they can be summarized below table.

	Traditional group	Cooperative group
I like it	11%	17%
For my future	11%	29%
Interesting	15%	25%
Help to think	11%	0%
Indiferent	7%	4%
I do not understand	7%	0%
I am not interested	15%	4%
Unuseful for my future	0%	4%
Boring	21%	17%

Table 1. Motives for the physics punctuation.

The positive intrinsic motives towards physics are chosen in more than one fourth of the cases in both groups, the extrinsic motives receive fewer choices. As for the negative motives it is polarized in that it is bored and that they are not interested.

Sources of motivation

Now there are several questions to detect the possible factors that can have influence in the student at the moment of be motivating before the classes of physics. In the tables 2 and 3

the scale is: 5=a lot of interest; 4=fairly interest; 3=indifferent; 2=little interest; 1=nothing of interest.

Questions	1	2	3	4	5
The importance of the physics in the society	3%	22%	29%	31%	15%
Factors like father, mother, friends, etc.	14%	10%	38%	25%	13%
The characteristics of physics	6%	9%	44%	31%	10%
The specific characteristics of teaching and learning physics	2%	15%	54%	23%	6%
Exercises and tasks made in physics	6%	16%	36%	29%	13%
The textbook and other materials used in class	6%	14%	27%	33%	20%
The qualities of the teacher	5%	8%	17%	34%	36%
My natural way of being and to behave	5%	5%	24%	46%	20%

Table 2. Sources of motivation.

46% of the students consider physics important, as for the own characteristics of the physics, materials, exercises and textbook they are interested 41%. The environmental factors influence less than 40%. The qualities of the teacher of physics help many students and also the way of being of themselves uses as help according to their opinion for the study of the physics.

Dominant motives in the study of physics

We are going to show the information of the students in order to define as good as possible the motives for which the students study physics.

Questions	1	2	3	4	5
Study science in high school	20%	18%	18%	30%	14%
To study engineering or architecture	16%	15%	19%	27%	23%
To get a good job	2%	5%	6%	26%	61%
Enjoy a more completed education	5%	10%	27%	35%	22%
Accomplish with an academic requirement	28%	14%	27%	16%	15%
Interested in knowing the scientific culture	17%	24%	38%	17%	0%
To understand the daily devices	17%	23%	32%	21%	7%
To understand the daily natural phenomena	16%	25%	40%	16%	3%

Table 3. Dominant motives in the study of physics

The majority of the students show great interest for the physics due to the future: baccalaureate of sciences, university studies of sciences or to obtain a good work. Nevertheless, the intrinsic motives of physics are interested less like enough one sees in the questions 6 to 8.

Motivational effect of the teaching and learning situations

In the last part of the test the questions look for how or what influence the different situations that are given in the classroom affect the students, the presence and influence of the different prejudices that the students hide in their minds and the circumstances of their personal and familiar environment that affect these teen students.

The scale is: 5=much; 4=often; 3=sometimes; 2=little; 1=never.

Questions	1	2	3	4	5
When the teacher encourage me	14%	12%	23%	25%	26%
When i am punished, my motivation decreases	22%	21%	27%	15%	15%
When the tasks are easy I am more motivated	12%	9%	32%	27%	20%
The tasks which they are a challenge help me	19%	16%	28%	25%	12%
I am more motivated with good results	3%	10%	27%	27%	33%
The work at group motivates me	7%	8%	38%	33%	14%
To participate in the curricula decisions	12%	15%	42%	20%	11%
To participate in the assessment process	14%	16%	34%	25%	11%
When i work alome i am more motivated than when i work at group	23%	17%	38%	15%	6%
I am motivated when i participate in the class	10%	13%	22%	27%	28%
When the class satisfies my interests	8%	15%	43%	23%	11%
To speak before the class	13%	8%	57%	17%	5%
The competitions help me	9%	13%	35%	28%	15%
To find out closely about the aims and of the contents motivates me	10%	23%	39%	25%	3%
When I do not take part in class	17%	25%	37%	10%	11%
When they do not give me the made things	18%	18%	29%	30%	5%
When the teacher uses audiovisual means	4%	3%	15%	15%	63%

Table 4. Motivational effect of the situations of education and learning.

These students prefer encouragement to the reproach though they admit in 30% of the cases that the second thing also serves them. There is diversity of opinions before situations that they can present, for example that the tasks of physics may be easy they motivate 47%, that the exercises may suppose a challenge motivate 37%. On having asked them on the participation in the curriculum or the evaluation motivates to a third of the students, and turns out to be to them indifferent to a third of them approximately. On having asked them on if they prefer worked at group or individually they prefer at group, 40% affirms that it motivates them and only 21% to affirm the same of the individual work.

As for the participation in class, it motivates almost 60% of the students, only 21% are motivated by listening to the teacher passively, nevertheless only 22% of the students like to do expositions. The relevancy of what explains or the detailed description of what is going to be studied only motivates 25-30% of the students. The tasks seen as a competition they interest 43%. To discover the facts alone helps them, but especially they are motivated -78%- when the teacher uses audiovisual means.

Observation of the teacher during the classes

After the motivational pretest the teacher gave twelve classes, six weeks, the teacher took *Table 7. Interest in each subject before and after the experience according to the methodology.* notes of what he noticed, in addition he ordered assignments daily in order that the students made them in house and asked in class contents that had explained in the previous days. The percentage of students of the traditional group and of the cooperative group who made the exercises daily is similar, 82% in the traditional and 84% in the cooperative group. On the other hand, on having asked daily 25% of the students of every group, the result was significantly different, 24% of the students of the traditional group was succeeding the response and 62% in case of the cooperative group. In addition, the sensation of the teacher was that the students in the traditional group were getting bored and in the cooperative group the class was becoming short. The classes lasted one hour.

Motivational posttest

After making the experience the motivational posttest was applied, we are going to observe if differences exist with the motivational pretest.

Motivation in class

In the first part it is shown the averages of the diverse questions realized before and after the experience. The general results to the first questions: grade of interest, attention in class, effort for learning and dedication in general in every group they have been:

	Interest	Attention	Effort	Dedication
Traditional before	4,00	4,06	4,16	3,81
Traditional after	3,48	3,41	3,48	3,24
Cooperative before	3,84	3,72	3,81	3,66
Cooperative after	3,45	3,59	3,72	3,38

Table 6. Interest, attention, effort and dedication in general.

The results show that in the students, as the year passes, the degree of interest, of attention, of effort and of dedication decreases. In the traditional one the punctuations lower more that in the cooperative group. This qualification corresponds to all the subjects, a general vision. Table 7 shows the results on the interest that the subjects provoke, discriminating in those that more they are interested of that less, before and after the experiment, according to the method that is indicated:

	Traditional before		Traditional after		Cooperative before		Cooperative after	
Subject.	Most	Least	Most	Least	Most	Least	Most	Least
Mathematics	21%	0%	22%	0%	9%	16%	15%	0%
Language	32%	12%	22%	19%	27%	8%	10%	0%
Physics	11%	12%	11%	25%	9%	8%	35%	6%
Technology	0%	0%	0%	0%	0%	0%	0%	0%
Biology	5%	24%	6%	19%	18%	4%	15%	16%
Chemistry	0%	0%	0%	0%	0%	0%	0%	0%
Geography	21%	0%	33%	0%	5%	32%	5%	50%
Music	0%	29%	0%	6%	0%	8%	0%	0%
Arts	5%	23%	6%	31%	23%	12%	20%	28%
Physical ed.	5%	0%	0%	0%	9%	12%	0%	0%

Table 7. Interest in each subject before and after the experience according to the methodology.

In the traditional group the disinterest has increased for physics. Other results remain more or less constant, except Language and Geography. In the cooperative, the interest for the Physics has grown reaching after the application of the methodology 35%, it is the most interesting subject. In Table 8 the degree of attention appears provoked, major or minor, before and after the experiment, according to the method that is indicated.

	Traditional before		Traditional after		Cooperative before		Cooperative after	
Subject.	Most	Least	Most	Least	Most	Least	Most	Least
Mathematics	22%	28%	37%	0%	39%	6%	0%	21%
Language	17%	6%	21%	0%	6%	0%	23%	0%
Physics	0%	0%	16%	23%	17%	0%	68%	0%
Technology	0%	0%	0%	0%	0%	0%	0%	0%
Biology	11%	17%	11%	23%	28%	13%	5%	16%
Chemistry	0%	0%	0%	8%	0%	0%	0%	0%
Geography	28%	0%	11%	8%	6%	81%	0%	47%
Music	0%	22%	0%	8%	0%	0%	0%	0%
Arts	11%	17%	4%	31%	0%	0%	4%	16%
Physical ed.	11%	10%	0%	0%	4%	0%	0%	0%

Table 8. According to the methodology, the subject which the students pay more attention and less.

In the traditional group, 23% affirmed that physics was where they pay less attention or more relaxes. Nevertheless, after the experience 16% places it as the subject to which they pay more attention. On other results they highlight the changes in the attention in geography and the major distraction in arts.

In the cooperative group the change is very positive in Physics: it raises from 17% to 68% the number of students who pay particular attention.

The information appears on the effort below:

	Traditional before		Traditional after		Cooperative before		Cooperative after	
Subject.	Most	Least	Most	Least	Most	Least	Most	Least
Mathematics	25%	13%	30%	0%	50%	11%	25%	13%
Language	13%	7%	30%	8%	18%	0%	15%	6%
Physics	21%	7%	13%	25%	9%	0%	45%	0%
Technology	0%	0%	0%	0%	0%	0%	0%	0%
Biology	13%	7%	13%	8%	14%	6%	10%	19%
Chemistry	0%	0%	0%	8%	0%	0%	0%	0%
Geography	4%	7%	4%	8%	0%	50%	0%	38%
Music	4%	13%	0%	8%	0%	6%	0%	6%
Arts	4%	27%	10%	35%	0%	17%	5%	18%
Physical ed.	16%	19%	0%	0%	9%	10%	0%	0%

Table 9. The students choose the subjects in which they make more and less effort according to the methodology.

In the traditional group the effort has decreased in Physics: one fourth of the students designate her as the subject in the one that they make less effort and they are less those who choose it as the subject in which they make more effort.

The results of the cooperative group in relation with the effort are: 45% of the students choose it as the subject in which they make more effort.

The table that continues refers to the degree of dedication:

	Traditional before		Traditional after		Cooperative before		Cooperative after	
Subject.	Most	Least	Most	Least	Most	Least	Most	Least
Mathematics	23%	29%	25%	8%	21%	0%	5%	19%
Language	14%	7%	45%	0%	42%	0%	41%	0%
Physics	5%	0%	20%	31%	0%	14%	32%	0%
Technology	0%	0%	0%	0%	0%	0%	0%	0%
Biology	18%	0%	5%	23%	4%	5%	14%	13%
Chemistry	0%	0%	0%	8%	0%	0%	0%	0%
Geography	5%	0%	0%	0%	0%	45%	0%	56%
Music	5%	21%	0%	15%	0%	9%	0%	0%
Arts	27%	14%	5%	15%	29%	18%	8%	12%
Physical ed.	3%	29%	0%	0%	4%	9%	0%	0%

Table 10. The students choose the subject according to the degree of dedication and the methodology.

In the traditional group the percentage of students who devote themselves with more determination grows in Physics coming to 20%, in addition almost a third of the students affirm as if they had left Physics and Biology. For the students of the cooperative group, Physics does not reach the first position, 32% but it is the subject in which a major change exists to better.

Degree of motivation in class of physics

We expose the answers on the degree of motivation in class. The scale in tables 11 to 15: 5=Much; 4=Fairly; 3=Indifferent; 2=Little; 1=Nothing.

Questions	Group	1	2	3	4	5
Did you enjoy with the physics classes?	Trad.	10%	34%	39%	14%	3%
	Coop.	0%	7%	16%	47%	30%
In what measure have you liked the used means?	Trad.	34%	17%	36%	10%	3%
	Coop.	0%	4%	21%	43%	32%
Have you paid more attention?	Trad.	17%	17%	28%	31%	7%
	Coop.	4%	0%	25%	39%	32%
Have used means done that you pay more attention?	Trad.	41%	24%	29%	3%	3%
	Coop.	7%	0%	28%	31%	10%
Have you interested in the physics contents?	Trad.	10%	21%	28%	31%	10%
	Coop.	4%	11%	10%	54%	21%

Table 11. Degrees of motivation in class according to the methodologies.

More than 70% of students of the cooperative group demonstrate that they enjoyed in the classes, the means helped them to pay more attention and they were interested in the

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classes. In the traditional group the opposite opinion reached almost 50%, except on having questioned them about the interest for physics and the attention in class that they are little more than 30%. The motives for the previous response show in the table 12:

Motions	Traditional	Cooperative
Too many problems	4%	0%
I am of letters	4%	5%
Boring	35%	5%
I do not understand it	12%	5%
Indifferent	0%	0%
For the future	12%	5%
Interesting	4%	32%
I like the problems	8%	0%
I like it	8%	0%
Resources	0%	16%
Funny	0%	16%
Otrhers	13%	16%

Table 12. Motives of the punctuation of physics according to the methodology.

Inside an apparent dispersion, it is possible to appreciate that the negative motives in the traditional group promote 54%; in the cooperative group they reach 15%. The positive motives reach 46% in the traditional group and 85% in the cooperative group. Between other answers they emphasize the "connection with the daily life", "it is an easy subject", etc.

Motivational power of physics

Now we show the punctuation given to other subjects to see if the change produced in Physics owes more to an emotional state than to the influence of the methodologies. In table 13 the results of interest appear that they take as the different subjects of the year. The students have been requested on the physics only the experience with the different methodologies.

	Traditional		Cooperative	
Subjects	Before	After	Before	After
Mathematics	4,03	3,76	3,53	3,59
Language	3,97	3,48	3,56	3,79
English	4,25	3,17	3,38	3,17
Geography	4,47	3,59	2,97	3,00
Physics	3,44	2,59	3,19	4,07
Chemistry	3,31	2,28	3,12	2,66
Technology	3,66	2,76	3,25	2,97
Physical ed.	3,22	3,07	3,59	3,59
Biology	3,50	3,10	3,53	3,14
Arts	3,47	3,03	3,34	3,03

Table 13. Punctuation of the interest of the students in the subjects of the year.

The information reflects that the students tend to qualify their interest lower than the first time, the interest of the traditional group have decreased in English and Chemistry in more than one point whereas Physics, Technology and Geography in approximately 85 hundredth ones. Therefore the percentage decrease in the punctuation of Physics is normal in comparison with other subjects. In the cooperative group there is an extraordinary raise in the interest of Physics, is the one that more rises with 88 hundredth ones. Physics in the traditional group changes from 8th place with 3,44 to 9th place with 2,59. In the cooperative group, physics was also in 8th place with 3,19 and it rises to the first place with 4,07.

To illustrate more the change produced by the cooperative learning in the students, a study with 16 year old students made by Solbes (2011), he showed that the students say that Physics and Chemistry is of minor interest that the Physical Education, Technology, Arts, English, Mathematics, Geography. In the same article the author concludes that "physics, chemistry, biology and geology are bored for the students, difficult and excessively theoretical "(Solbes, 2011: 60).

With the information of physics it is possible to realize also an illustrative comparison after the realized experience. This one is the punctuation that they have given to physics before the experience and later.

Group	Moment	1	2	3	4	5
Traditional	Before	7%	28%	21%	34%	10%
	After	14%	34%	34%	14%	4%
Cooperative	Before	7%	19%	34%	31%	9%
	After	0%	3%	14%	55%	28%

Table 14. Punctuation of the interest of the students of physics.

The methodology has influenced positively and significantly in the cooperative group, from 40% to more than 80%. On the other hand in the traditional group of having a big disinterest, 35%, to having it in 48%; it has increased this disinterest, as we have said, of form similar to other subjects of the year.

Conclusions

In the study of the motivations carried out in this research the following conclusions are gathered:

1st) The students show a great confidence in their possibilities before the challenge of physics and assume the absolute responsibility of their successes or failures.

2nd) They show a good degree of interest, perseverance, effort and attention.

3th) Interest in Physics reaches an intermediate punctuation between the subjects that they deal. The positive motives are that "the physics is interesting" and "it will serve me for the future"; the negative motive specially is “physics is boring”. The exercises and the materials that are used in the classes is what more motivates them. They consider possessing conditions that make them compatible with physics. The interest, partly, is motivated by some relative who has done studies of physics.

4th) Motives that encourage them to study physics: the professional future, the future studies, the university degree (extrinsic motivation). If Physics helps to understand daily phenomena or devices that use habitually do not help them (intrinsic motive).

5th) Students are motivated by the use of the audiovisual resources, the exercises, the facility of the subject, the rapid understanding of the concepts, the success in the examinations, the cooperative work, the participation in class. They are not motivated by the expositions in class.

6th) The final information is very positive about the research. For the students of the cooperative group: Physics is the subject in which they pay more attention, have major interest, make more effort and work with more perseverance, around 60%. The positive motives are that they are interested in the subject more than 30% and the "connection with the real life". On the other hand the interest of the traditional group does not come to 25%.

7th) Students of the traditional group feel more unmotivated after the research. However, their interest has decreased the same as other subjects, which means that didactic differences have not caught respect of other subjects.

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